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A Review of the Transport Behaviour of Solvents through Fiberglass-Epoxy-waste- Polypropylene Composites

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I. INTRODUCTION

The study of transport behaviour of polymer composites are of high importance since most swollen polymers had decreased properties. In commercial applications and in the area of chemical production processes, it is important that these polymers and composites remain chemically stable while retaining their mechanical properties on contact with solvents. It is as result of this that the basic transport phenomenon plays vital role in engineering and industrial uses of textile and polymers [George et al, 2000]. The sorption interaction between polymer composites, and additive components is a vital mechanism of interface layer formation.

Composites are materials for engineering which are obtained by combination of two distinct parts, namely: matrix and additive. They are multiphase materials that combine the properties of their constituents to acquire a unique composite property (Berthelot, 1996; Glossaire Les Materiaux, 2006). The factors which affect composites are the nature of materials (Kommann, Linderg, & Berghenol, 2001), the reinforcement, matrix quality, interface of the filler and synthesis process.

The investigation of reinforcement integration into matrix in order to determine specific functions has been studied (Bondioli, Cannillo, Fabbri & Messori, 2005; Gerdinarid, Budde, & Kurrat, 2004; Janssen, Seifert & Karner, 1999).

They are usually heterogeneous in nature, that is to say they are created in assembly of two or more components; where the additive is not natural, a compactibiliser is employed to bring about adhesion. The first composite manufactured could have been the mixture of straw and mud to make bricks which had exhibited compression, tearing and squeezing properties that gave rise to excellent building blocks. It has been observed that if the different materials do not dissolve or blend to each other, they can be separated (Ajith, G. et al. 2014). In the early 1960s, composites with weight saving abilities over aluminum were developed for aircrafts (Scott, 2005). There are basically two composite types; natural and synthetic. The natural composites are obtained by the combination of natural materials with either textile or polymers as the matrix.

However, some polymers come in nature; hence there are composites in nature such wood which consists of containing lignin-long cellulose fibres. Cellulose is also found in cotton fibres which have no lignin to bind it together and hence is weaker. Lignin and cellulose combine to form much stronger material.

Another natural composite is the human bone which consists of hard but brittle substance called hydroxyapatite (mainly calcium phosphate) and a soft and flexible substance referred as collagen (protein). John Wesley Hyatt had developed a cellulose derivative used commercially in the manufacture of dental plates (Robert, 2000).

On the other hand, synthetic composites are obtained from petroleum sources (hydrocarbons). They are either thermoplastic and thermoset composites, depending of the base matrix used. The first synthetic composite obtained was the fiberglass (Bryan, 1999) from macromolecules of silica.

The fillers used as additives come in different ways; particulate, unidirectional and/or short strands. In this research work, the fillers were used in particulate forms. Therefore, particulate reinforced composites are composites whose fillers have roughly equal dimensions. They are used to enhance performance of temperature, resistance to wear, and shrinkage as well as friction reduction.

II. A REVIEW OF THE TRANSPORT BEHAVIOUR OF SOLVENTS THROUGH FIBERGLASS-EPOXY-WASTE- POLYPROPYLENE COMPOSITES

There had been recent studies on the application of polymer composites in the protection of soft rocks. The basic concepts, principles and requirements of such composites for highway engineering were examined and documented. The relevant theoretical analyses, design and construction were articulated in recent studies (Yao, Zhou, & Hongzhuan, 2016).

The sorption through polymeric composites at molecular level is a kinetic phenomenon that depends the material's free volume, segmental mobility of the polymer's chain, and the penetrant molecular size. This phenomenon is influenced highly by the nature, morphology, crosslinking density of polymers, temperature, shape, and size of the probe penetrant molecules [Aminabhavi & Naik, 1999].

The swelling of polymeric materials in aromatic solvent environment is highly essential for certain areas of applications such as controlled release systems [Koros, 1990]. Investigation on the influence penetrant molecular size and structure of composites on the sorption and properties of substituted benzenes through commercial polymeric systems had been carried out (Aminabhavi, et, al., 2000). From the curve obtained, there was an observed "S" shape indicating relaxation effects showing non fickian mode. The effect might have arisen from the delay in response to the developed swollen stresses.

Sorption and diffusion results measured at different temperatures of 20, 40 and 60^{o}C had been found to follow Fickian mechanism (Unnikrishnan & Thomas, 1998). There was reduction in rate of adsorption in relation to rise in crosslinking density. Coefficient of diffusion and solubility of solvents were found to correlate with the molecular weights and dipole moment. They also conducted the examining of the interaction of aromatic solvents with different polymeric systems.

The diffusion coefficients derived vary from the sorption coefficients, implying that different mechanism occurred. The heat and mass transport behaviour of polypropylene based nano-composites and the effects of chemical functionalization of multiwall carbon nanotubes have been reported (Russo, et al., 2015). The transport phenomenon had been found to be related to the structure of polymers.

The sorption rate and magnitude tend to decrease with induced crystallinity at higher temperatures (Harogoppad and Aminabhavi, 1991).

2.4.2 Review of transport behaviour of solvents through fiberglass wastes composites

There had been scholarly articles on the fiberglass wastes composites. The need to review such articles arose in order to fill in the knowledge gap that the fiberglass epoxy wastes have not been used as fillers for polypropylene.

Sorption studies had been conducted on the fiberglass wastes/polyester resin composites in order to obtain the rate of adsorption of water. Results indicated that composite properties were completely changed by the presence of the water (Edeleide, et al., 2006).

2.4.3 Transport behaviour of solvents through fiberglass epoxy waste filled polypropylene composites

Citek, et al, (2018) had investigated the application of fiberglass waste polypropylene aggregate in lightweight concrete. They evaluated the properties of a sustainable light weight concrete incorporating high volume of waste polypropylene aggregate as substitutes of material aggregate. The fiberglass polypropylene composite utilized was a by-product of polypropylene tubes and it replaced fine natural silica aggregate in 10, 20, 30, 40 and 50 mass%. A reference concrete without paste waste was used to compare the results while the thermal transport and storage properties were examined in dependence of compaction time.

In the construction industry, concrete has been extensively used due to its durability and permanence. However, it has been characterized by cracks. This calls for reinforcements with fibres, fiberglass wastes and fiberglass composite wastes which combines the sorption properties of the matrix and the additives.

Transport behaviour of nitrile rubber/polypropylene and ethylene-propylene rubber/nylon blends have been studied [George et al, 2000]. The reports showed excellent results in the sorption properties of those blends.

The effects of parameters of materials on the sorption properties of polypropylene filed wood flour composites have been studied (Steckel, et. al., 2007). There was observed interaction between the wood-flour content and the surface treatment.

Studies on the sorption characteristics of asphalt mastics using manual and automated gravimetric sorption techniques had been studied. (Alex, James & Gordon, 2). The sorbed water and coefficients of diffusion were obtained by static and dynamic gravimetric vapour sorption method. The 25mm diameter thin alphalt mastic films and testing conditions of 28°C and 85% relative humidity were considered.

In this present study, there is need to compare the sorption properties of the fiberglass wastes filled polypropylene composites with the results of the conventional practice of mechanical stabilization of soil and also the developed methods of using polymers to stabilize the soil.

There is rapid development in the transportation and construction industries owing to their sizes and relevance which usually affects life aspects. In the transport industry, this includes movement of people and goods by means of aircraft, automotives, ships, and trains. The usage of textile and polymer materials, and composites in this industry is rapidly rising due to the zeal in moving towards achieving sustainability as well as performance, safety and comfort enhancement.

The demands for sustainability in this sector could be fulfilled in textile and polymer composites through the application of renewable, light weight and recycled materials. In recent time, roads have moved away from bitumen (asphalt) to technical textile polymeric applications. Research had it that textile and polymer composites could be used in creation of roads by stabilization of soils, reinforcement of asphalt and dust/erosion control (Mallard Creek Polymers, 2019).

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